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Full Integrated Collaborative Rerouting (ICR) Evaluation Report

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1 Abstract

This paper documents storyboard, demonstration, and human-in-the-loop (HITL) evaluations conducted during fiscal year 2005 to define, validate, and refine the Integrated Collaborative Rerouting (ICR) concept and requirements. ICR is an enhanced, more collaborative version of rerouting that involves customers early in the process and allows them to submit preferences for reroutes. The ICR concept is based upon reroute modeling, generating route options from a pre-coordinated database, and collaboration between Federal Aviation Administration (FAA) traffic management and customers. The evaluations focused on each step within the concept using prototypes developed by The MITRE Corporation's Center for Advanced Aviation System Development (CAASD) and Metron Aviation, Inc. to give the look and feel of a seamlessly integrated system. Evaluation participants included FAA traffic managers, commercial carriers (aircraft dispatchers, air traffic coordinators), and general aviation (flight followers). Participant feedback and data collected during the HITL evaluations have been captured in this document.

KEYWORDS: ICR, Integrated Collaborative Rerouting, rerouting, reroute modeling, collaboration, traffic manager, customer, TMU, dispatcher, flight following, commercial aviation, general aviation, ATCSCC, Air Traffic Control System Command Center, Traffic Management Unit, Route Options Generation, ROG, Constraint Resolution Intent, CRI, Future Traffic Display, Planning Advisory, Reroute Monitor

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3 Table of Contents

List of Figures

6

7

8

9 List of Tables

10 Section 1

11 Introduction

The Integrated Collaborative Rerouting (ICR) Concept was developed to provide an enhanced, more collaborative approach to rerouting flights when managing en route congestion. ICR is an enhanced, more collaborative version of rerouting that involves customers early in the process and allows them to submit preferences for reroutes. The ICR concept is based upon reroute modeling, generating route options from a pre-coordinated database, and collaboration between Federal Aviation Administration (FAA) traffic management and customers.

The ICR Concept was developed under the auspices of a Collaborative Decision Making (CDM) working group, the Future Concepts of Flow Management Sub-Team (known as the FCT)[1]. That working group includes members from the FAA, air carriers, and business aviation, as well as private industry, academia, and aviation research organizations. The working group was tasked with identifying and addressing areas for improvement in traffic flow management (TFM).

The FCT refined the ICR Concept through a series of evaluations conducted by The MITRE Corporation's Center for Advanced Aviation System Development (CAASD) and Metron Aviation, Inc. The evaluation participants included FAA traffic managers from the Air Traffic Control System Command Center (ATCSCC) and from local Traffic Management Units (TMUs), and airspace customers, such as dispatchers, air traffic coordinators from air carriers, and flight followers from business aviation.

This paper documents the evaluations conducted during Fiscal Year 2005 (FY05) to define, validate, and refine the full ICR concept [1] and its functional requirements [2]. Later evaluations, conducted in Fiscal Year 2006 (FY06), explored the feasibility of an incremental approach to implementing the ICR Concept. Those FY06 evaluations, covered in a separate document, helped refine the first increment (Initial ICR), which is documented in the Initial ICR operational concept [3] and functional requirements [4].[2]

Section 2 describes the initial evaluations that were conducted to define and establish the initial feasibility of the ICR concept and the associated automation capabilities. Section 3 covers the human-in-the-loop (HITL) evaluation process, the laboratory set-up for the evaluations, and details on each of the three HITL evaluations. Section 4 provides a summary

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1 Until early 2005, this group was known as the Integrated Concepts for the Evolution of Flow Management (ICE-FM) working group.

2 Priority was given to preparing the operational concept and requirements, as well as to the Initial ICR tasks, hence the delay in issuing this evaluation report.

of the benefits identified during the evaluations and next steps for implementing the ICR process.

Throughout the remainder of this document, references to customers are understood to include commercial carriers (air traffic coordinators and dispatchers), business aviation (flight planners and pilots), and General Aviation (pilots). In addition "traffic managers" used without any qualifier refers to both local TMU and national ATCSCC TFM personnel.

11.1 1.1 Overview of Concept Development Activities

The FCT leveraged the work previously done by the CDM FEA/FCA working group that addressed en route congestion in the National Airspace System (NAS). That work introduced Flow Evaluation Areas (FEAs), Flow Constrained Areas (FCAs) and customer-submitted Early Intent messages as tools to help manage congestion and developed a process for using them. The FCT members felt that enhancing that process to make it even more robust and collaborative was a key element in improving NAS operational efficiency. Therefore, the ICR Concept was designed to give customers more incentive to participate. It is important to note that, in addition to procedural improvements, the ICR concept introduces important new automation capabilities that are key to an improved collaborative en route congestion management process.

Once the FCT members reached agreement on an initial high level ICR concept, storyboard evaluations were conducted to better understand its practical applications and solicit feedback. These discussions mapped out lower levels of detail and established the basic prototype requirements necessary for conducting HITL evaluations. A prototype demonstration and three HITL evaluations were then conducted to further refine and validate the ICR concept. Table 1-1 presents an overview of the ICR concept development timeline. Each activity and its results are described in more detail in Sections 2 and 3.

A.1.1 Table 1-1. ICR Development Timeline

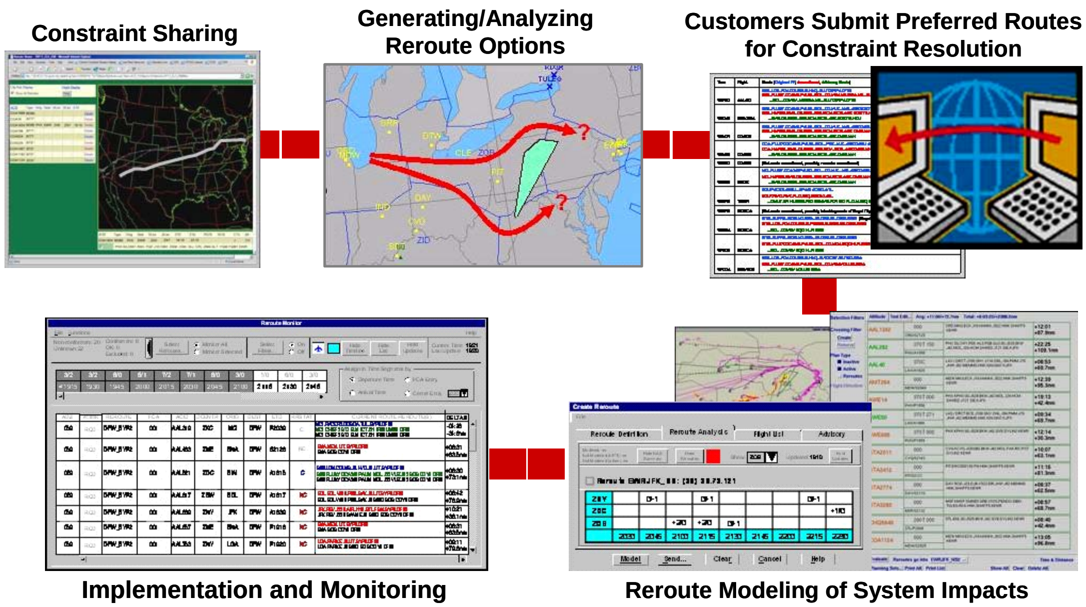
Date	Location	Activity	Results
4 November 2004	MITRE	Walk through concept storyboards	Identified need for earlier role for customers, more streamlined coordination process, and sharing of modeling results
9 December 2004	Metron Aviation	Walk through revised concept storyboards	Monitored secondary impacts; Improved coordination between local and national traffic managers; Visualize modeling results with Future Traffic Display
1 February 2005	MITRE	Demonstrate concept capabilities in lab	Improved customer route selection, enhancements for Reroute Monitor; Ready to move to human-in-the-loop evaluations

Date	Location	Activity	Results
22 & 23 March 2005	MITRE	Conduct human-in-the-loop evaluations	Additional up-front TFM coordination on defining problem; Better filtering of flights to be rerouted; Better handling of flights to/from smaller airports
10 & 11 May 2005	MITRE	Conduct human-in-the-loop evaluations	Identified where to focus TFM attention, checking that submitted routes are acceptable and meet constraints; Analyzed comparative modeling results
20 & 21 July 2005	MITRE	Conduct human-in-the-loop evaluations	Refined the coordination process between national and local traffic managers; Involved more customer information via remote participation

11.2 1.2 Brief Overview of ICR Concept

Because the Full ICR operational concept [1] and functional requirements [2] are described in previously published documents, only a brief overview of the concept is provided in this section. Integrated Collaborative Rerouting is a concept for handling reroutes using more collaborative and flexible methods. It integrates existing capabilities with new automation capabilities to produce a rerouting approach that should increase system predictability while allowing customers significantly increased opportunity to request preferred reroutes before having a reroute mandated.

At a high level, the ICR Concept can be visualized as having five stages (see Figure 1-1). First, traffic managers define a constraint in terms of a list of flights that need to rerouted and share it with the customers. Second, the customers generate and analyze reroute options, deciding which, if any, they have a preference for how the flight will be rerouted. Third, the customers submit those preferred routes via Constraint Resolution Intent (CRI) messages to traffic management automation. Fourth, traffic managers analyze customer-submitted reroutes; generate reroutes for flights for which no customer preferences were submitted; and then model the impact of the combined proposed reroutes on the system to refine the reroute plan that will be implemented. Finally, the reroutes are implemented and traffic managers and customers monitor the results.



A.1 Figure 1-1. ICR Process

11.3 1.3 Evaluation Participants

Participants at the ICR evaluations represented a variety of operational perspectives: national traffic managers from the ATCSCC, local traffic managers from TMUs, and customers from operational control centers and flight planning offices. While basic operational roles were consistently represented, individual attendance varied. For instance, due to work schedule conflicts, the same traffic managers from the Washington Center (ZDC) TMU were not always able to attend, but other traffic managers from the ZDC TMU attended in their place. Although new attendees needed additional time to become familiar with the concept and capabilities, their fresh perspective and unique work experiences broadened the feedback received on the concept.

National Traffic Managers from the ATCSCC

The national traffic manager participants provided a national perspective for the ICR evaluation. Generally, the national traffic manager took a facilitation role, coordinating with the local traffic managers to identify the constraint, develop recommended reroutes, and assess modeling results. The national traffic manager was also responsible for issuing the planning advisory, making the final decision once modeling results had been analyzed by the traffic managers and issuing the final reroute advisory. National traffic manager participants included Severe Weather Unit specialists, National Traffic Management Officers (NTMOs), and National Operational Managers (NOMs).

Local Traffic Managers from TMUs

The local traffic manager participants reflected the multiple layers of expertise that are found in today's TMUs. Traffic Management Coordinators (TMCs) and Supervisory Traffic Management Coordinators (STMCs) participated, providing a well-rounded TMU perspective about how the ICR concept would affect local facility traffic management and air traffic control (ATC) operations. Local traffic manager participants came from Boston Center (ZBW), Cleveland Center (ZOB), Denver Center (ZDV), Fort Worth Center (ZFW), Minneapolis Center (ZMP), and ZDC.

Customers from Operational Control Centers and Flight Planning Offices

The customer participants provided the perspectives of commercial dispatchers and air traffic coordinators as well as general aviation flight planners. This combination of customers brought robustness to the concept evaluations as discussions covered both strategic and tactical situations. Customer participants came from the Air Transport Association (ATA), American Airlines, ARINC, Atlantic Southeast Airlines, Continental Airlines, the National Business Aviation Association (NBAA), Northwest Airlines, and US Airways. Customers submitted preferences for their own flights, and in some cases played the role of other airlines so that a larger number of customer preferences could be examined during the HITL evaluations.

Other Stakeholder Participants

In addition to the operational participants, other members of the FCT (from Volpe National Transportation Systems Center and Ohio State University) were in attendance for many of the evaluations to provide subject matter expertise and valuable concept feedback.

MITRE/CAASD and Metron Aviation staff facilitated all evaluations, providing technical expertise as necessary.

12 Section 2

13 Concept Exploration

This section describes the initial evaluations that were conducted to define and establish the initial feasibility of the ICR concept and the associated automation capabilities. It describes two storyboard concept evaluations and one prototype demonstration evaluation that were conducted. Each storyboard evaluation consisted primarily of a walk-through of a briefing describing in detail each step of the proposed concept. The early briefings contained detailed mockups showing the use of proposed new capabilities, plus screen snapshots showing the use of existing capabilities in the ICR concept. Since prototyping the new capabilities had already begun, in some cases screen snapshots from the prototype were included in the briefing or a brief demonstration of the early prototype was given.

13.1 2.1 First Storyboard Evaluation

At the November 2004 storyboard evaluation, the first version of ICR was presented to the group. The initial concept was based on the idea of getting customer feedback on several alternative rerouting plans developed by the FAA. National traffic managers would coordinate with local traffic managers to develop two or more reroute plans to avoid a constraint identified by the traffic managers. These reroute plans would then be shared with the customers to get preferences from each customer on the complete reroute plans (not on individual flights). Each plan contained flight specific reroutes and modeling results for those reroutes that the customers could evaluate. For example, three plans (A, B, and C) might be shared with customers. Plan A reroutes all flights north of the constraint; Plan B reroutes all flights south of the constraint; and Plan C is a hybrid of reroutes north and south of the constraint. Customers would then indicate which plan worked best for their flights by submitting their plan preferences via new automation or verbally by telephone. The traffic managers would then evaluate the customer responses as input to their final decision on which reroute plan to implement.

Both traffic management and customer participants in the storyboard evaluation felt that this initial concept for increased collaboration was not satisfactory. Traffic managers were concerned because it could potentially be time consuming to develop multiple reroute plans. Customers felt that they only had limited opportunity to provide input and it was too late in the process. Furthermore, customers were very interested in being able to provide flight-specific preferences on reroutes for their flights. In the initial concept, traffic managers were still selecting the reroutes for all flights. Therefore, it was decided to significantly revise the storyboard with much earlier customer involvement so they could provide flight specific reroute preferences to avoid a traffic-manager-defined constraint.

13.2 2.2 Second Storyboard Evaluation

The ICR concept was updated and presented to the FCT at a second storyboard evaluation in December 2004. Key elements of the revised concept include a two stage advisory process and the CRI message. An initial CRI Planning advisory would be issued that described not only the FEA constraint to be avoided, but also solicited flight-specific reroute preferences from customers. Customers would submit their flight-specific reroute preferences—CRIs—to the system during a specified time window. After receiving preferences from customers, traffic managers would develop the final reroute advisory using the customer flight-specific reroute preferences whenever possible.

Customer comments on the refined concept were mostly positive. However, traffic managers were concerned about a number of items, such as the operational acceptability of the customer submitted reroute preferences, the time required to review customer preferences, and how long the entire process might take. They also felt that the many new automation capabilities such as Route Options Generation (ROG), reroute modeling, and automated exchange of CRIs and modeling data, might alleviate many of their concerns.

Based on the storyboard evaluation, several enhancements to the concept and capabilities were recommended:

- The traffic managers' constraint identification and preplanning process should be streamlined.
- To increase the likelihood of the operational acceptability of CRIs, recommended route guidance should be included in the CRI Planning Advisory.
- To aid traffic managers in evaluating CRIs, a capability should be implemented to model the impact of planned reroutes (both CRIs and other reroutes that traffic managers are considering for flights for which CRIs are not submitted or for which CRIs are not acceptable) on other FEAs that traffic managers might define to monitor other key traffic flows or areas of concern, to determine whether those FEAs could be negatively affected by the planned reroutes.
- The final Route Advisory and Reroute Monitor should be modified to include modeling results, attach a flight list to the advisory, and display (with color coding) up to three routes for each flight in the Reroute Monitor ("original route," CRI, and final reroute).

Although some concerns were expressed about the evolving ICR concept, both traffic managers and customers felt that most of those concerns would be more effectively addressed and resolved during HITL evaluations. Therefore, it was decided to continue developing the prototypes of the ICR capabilities, including several new enhancements that were identified during this evaluation. The plan was to review the concept refinements and the actual prototypes at the next ICR evaluation to determine whether the concept and prototypes were ready for HITL evaluations.

13.3 2.3 Prototype Demonstration Evaluation

For the February 2005 ICR evaluation, demonstrations using the prototypes played a major role. The evaluation was conducted in two parts. First, a refined ICR concept storyboard incorporating the revisions recommended in the previous evaluation was presented. This was followed by a second pass through the full concept using the prototypes running with historical traffic data. The second run provided a much more realistic demonstration of the concept and enabled the evaluators to explore many aspects of the concept and human-computer interface in more detail.

The prototypes developed or enhanced by MITRE/CAASD and Metron Aviation for use in this and subsequent evaluations enabled evaluators to see and use high fidelity representations of most of the key capabilities used by traffic managers and customers as part of the ICR process. MITRE/CAASD's Collaborative Routing Coordination Tools (CRCT) prototype was used to demonstrate the following capabilities with a very high fidelity Enhanced Traffic Management System (ETMS) "look and feel":

- FEA/FCA definition
- Reroute definition and modeling
- Future Traffic Display
- Customer preference (CRI) receipt, display and modeling

The research version of Metron Aviation's Route Management Tool (RMT-R) was enhanced with ROG capabilities and customer preference submission capabilities. The CRCT and RMT-R/ROG prototypes were also enhanced to electronically exchange data with each other, to emulate the data sharing between traffic managers and customers specified in the ICR concept.

The participants in the February evaluation liked the refinements to the concept and felt that the concepts and prototypes were ready for the more rigorous evaluation of an HITL exercise. Several refinements were suggested:

- Make modeling results available throughout the process, not just after all CRIs are submitted
- Show a bar graph comparing sector volume before and after reroutes, with contributions to volume from CRIs and traffic manager-assigned routes indicated by different colors or hatching
- Provide modeling results on the customers' Common Constraint Situation Display (CCSD)

- Display the delta between the initial and final routes on Reroute Monitor, not deltas for intermediate routes (such as CRIs that were not accepted)

A major issue discussed in this and the previous evaluation was whether the reroute options provided in the initial CRI Planning Advisory should be recommended or required. Addressing this issue became a key element of the first ICR HITL evaluation.

14 Section 3

15 Concept Refinement and Validation

This section provides an overview of the HITL process and the laboratory capabilities used to validate and refine the ICR concept. It then provides a brief description of the scenarios and results of each of the three HITL evaluations that were conducted.

15.1 3.1 Human-in-the-Loop Evaluation Process

15.1.1 3.1.1 Scenario Development

The ICR HITL evaluations were conducted using historical NAS traffic data from a relatively good weather day (May 17, 2005). A library of weather scenarios was developed using actual weather data from days with significant convective weather. Weather overlays could then be superimposed on the traffic display. The traffic data for the significant convective weather days were not used because the actual severe weather initiatives that were imposed on those days perturbed the traffic flows. This approach provided the basis for exercising the concept using normal traffic flows under a variety of situations.

Each HITL evaluation focused on a series of runs, with each run presenting a scenario of congestion due to convective weather. A variety of scenarios were developed so that the evaluations could identify the situations in which the ICR process would be most valuable or effective. In some cases, the same weather was used for multiple runs but with some key change in the ICR process between each run, such as the nature of the guidance provided in the Planning CRI Advisories or the definitions of the filters on the FEA. In other cases, different weather events were examined.

15.1.2 3.1.2 HITL Participant Training

Each HITL evaluation included familiarization briefings and training exercises. This training helped participants establish basic skills for using the prototyped capabilities during the HITL runs. The participants were first briefed on the use of each of the capabilities. The briefing was followed by a hands-on exercise in which participants were able to use each of the capabilities in the context of the ICR concept steps. The scenarios used for training were different than the scenarios used in the actual HITL runs.

Each familiarization session was facilitated by a prototype expert and oriented to a specific participant’s role (that is, local traffic manager, national traffic manager, and customer) as appropriate. These sessions were well received by the participants and essential to the success of the subsequent HITL runs.

15.1.3 3.1.3 HITL Data Collection Process

Data from both the prototypes and the participants were collected for each run. Data from the prototypes were collected both automatically and manually. Manually collected data included screen snapshots of traffic displays, modeling results (during the first HITL), and the FEA and Reroute advisories that were manually constructed during the HITLs.[1] Automatically collected data included logs of traffic manager actions and automation activity, modeling results (time and distance deltas) for the second and third HITL exercises, and files generated during each run, such as customer CRIs, FEA/FCA definitions, and reroute flight lists.

Additional data were gathered by watching and listening to the participants. Observers at each position took notes on participants' actions and feedback. Position facilitators used structured interview questions to help in debriefing participants. A focused discussion was held with all participants after each run, to solicit additional feedback and identify issues. At the end of each HITL evaluation, a briefing summarizing the results of the HITL was presented to ensure that participants' comments had been captured.

15.2 3.2 Laboratory Set-Up

This section describes how the laboratory was set up for HITL evaluations, including what prototypes were used and a general idea of how they were interfaced to simulate an integrated environment.

To provide a collaborative environment in which to evaluate the ICR concept, multiple prototypes were loosely integrated for the appearance of a seamless system. Two major prototypes ensured both traffic manager and customer needs were addressed in the lab environment: CRCT, developed by MITRE/CAASD, and ROG capabilities, developed by Metron Aviation, Inc.

MITRE/CAASD and Metron Aviation coordinated message format and application programming interface specifications to give the appearance of a single integrated system for the HITL evaluations. As the ICR concept evolved and was refined, the prototypes also evolved to support further evaluations.

CRCT gives traffic managers the "look and feel" of the Traffic Situation Display (TSD), which they use to obtain Enhanced Traffic Management System (ETMS) data, view constraints, and maintain traffic situational awareness. CRCT was adapted to display the ICR simulation environment, enable traffic managers to create the constraint (a current ETMS capability) and associated flight list, provide enhanced "Create Reroute" capabilities, and provide reroute modeling (including modeling of CRIs). For evaluation purposes, reroute modeling capabilities were accessible from the "Create Reroute" function of the TSD.

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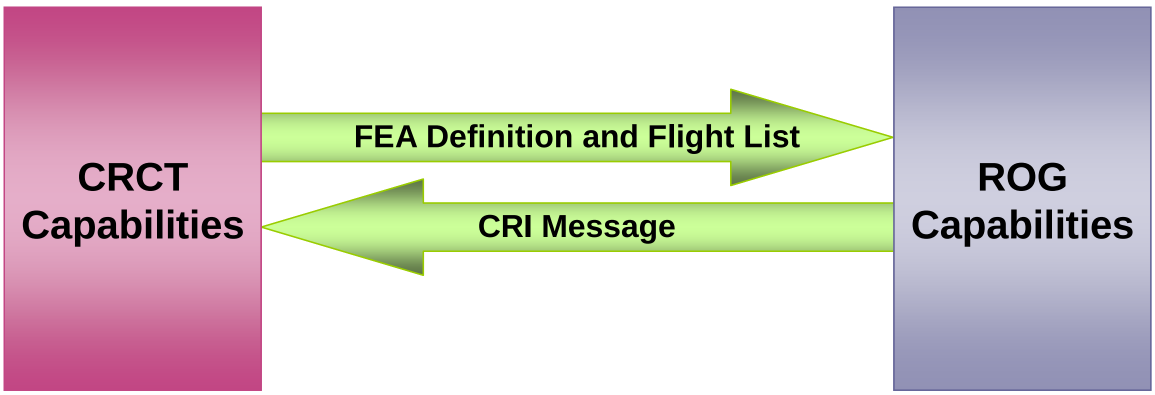
[1] An advisory generation capability was not available in the prototypes.

ROG prototype capabilities were developed in a research version of the Route Management Tool (RMT-R). The inputs to ROG are the FEA/FCA definition and the associated flight list. ROG enables both customers and traffic managers to identify route options from pre-coordinated route databases (such as Coded Departure Routes (CDRs), Playbook Plays and ATC Preferred Routes) that avoid the specified constraint. It also served as a surrogate for the customers' flight planning systems by enabling them to create CRI messages and submit them to the simulation environment (CRCT). ROG was provided to traffic managers to assist them in developing route guidance and reroute plans.

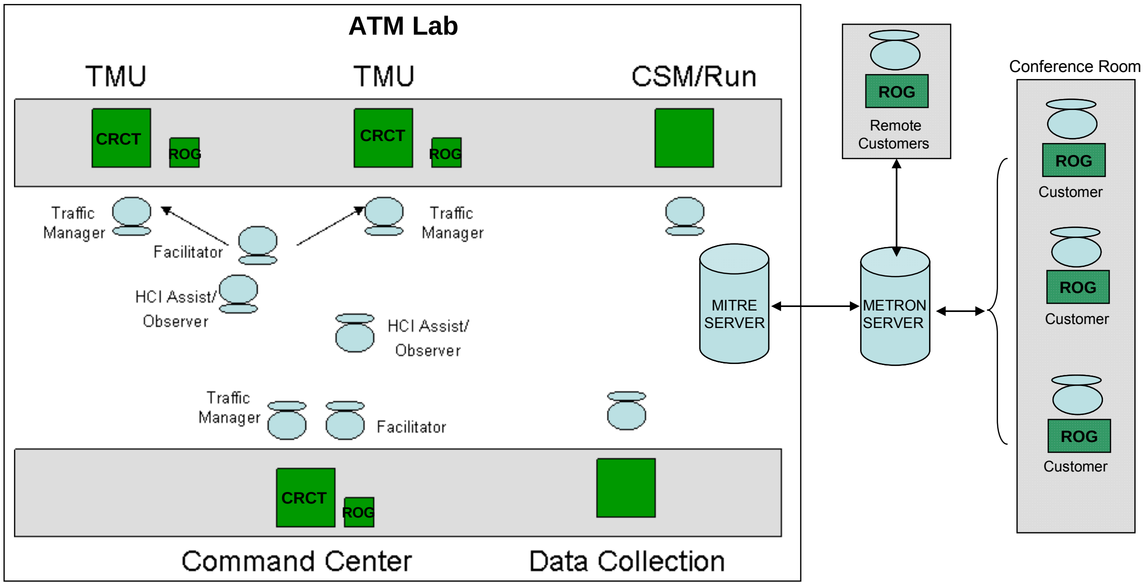
Some back-of-the-panel integration was necessary to enable the two prototypes (on different computer platforms) to communicate as shown in Figure 3-1. Currently, ROG can receive an FEA and associated flight list from CRCT and CRCT can receive CRI messages submitted via ROG.



A.1 Figure 3-1. CRCT-ROG Communication

The lab was physically configured to facilitate coordination between the local and national traffic managers. An example layout from the July 2005 evaluation is shown in Figure 3-2. MITRE/CAASD and Metron Aviation staff were stationed to facilitate the runs, to assist with human-computer interface (HCI) questions, and to observe. MITRE/CAASD staff also ran a data collection position and a position that monitored the Computer Simulation Manager (CSM)[2] for the runs. Metron Aviation staff also assisted customers at ROG positions located in a nearby conference room. For the July 2005 evaluation, Metron Aviation facilitators traveled with RMT-R/ROG to two customer operations centers, allowing remote participation.

[2] CSM manages behind-the-scenes tasks, such as synchronizing clocks and monitoring active processes in the computers.



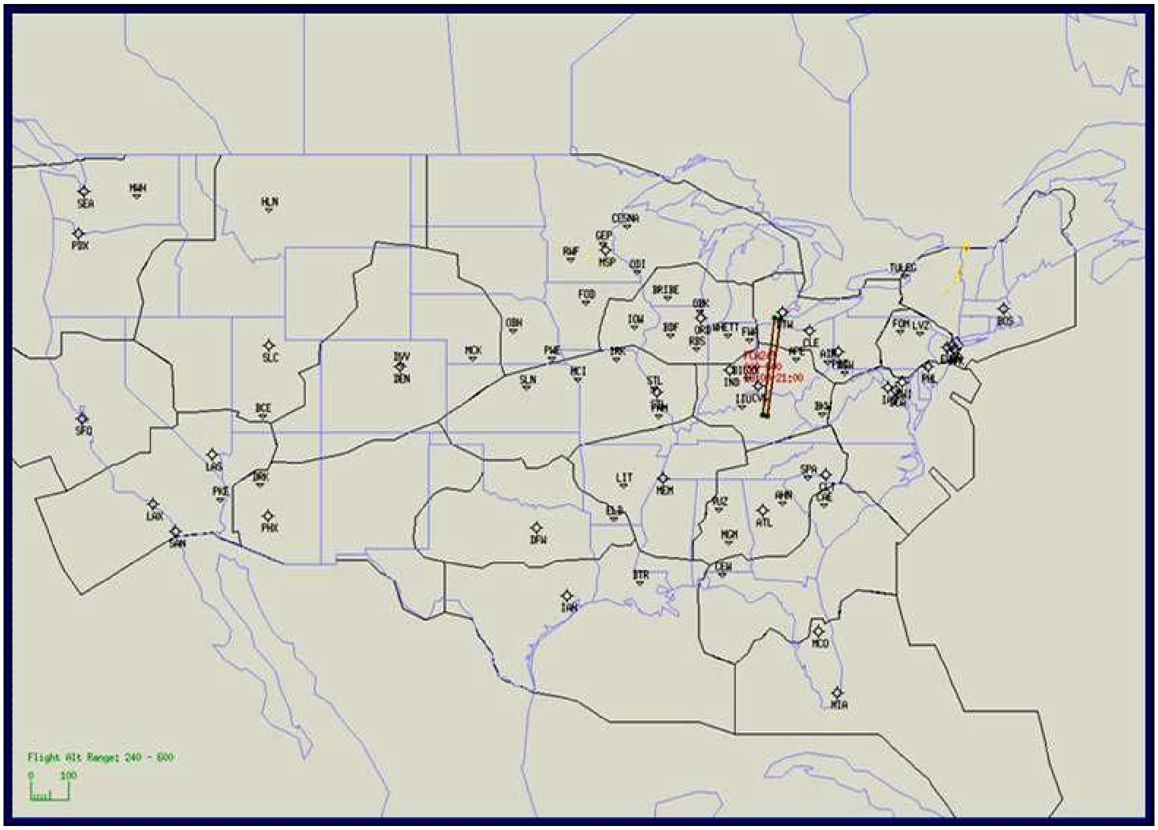
A.2 Figure 3-2. Example of Laboratory Environment (July 2005 HITL Evaluation)

15.3 3.3 First Human-in-the-Loop Evaluation

The first HITL evaluation, held in March 2005, was the initial opportunity for the members of the FCT to go through the proposed ICR concept with hands-on access to prototypes of the proposed ICR automation capabilities using recorded traffic scenarios. In addition to better understanding and validating the overall ICR concept, another important goal of the first HITL evaluation was to assess the role and importance of limiting or "structuring" the route options that customers could use in submitting their CRIs. Three of the four HITL runs allowed the customers different degrees of flexibility in selecting and submitting CRIs to avoid the constraint described in the CRI Planning Advisory. The fourth run was focused primarily on a novel approach to identifying the aircraft to be rerouted around the constraint. A brief description of the key elements of each of the four HITL runs is provided below:

- Run 1 – FAA provided recommended route options in the CRI Planning Advisory
- Run 2 – FAA specified required route options in the CRI Planning Advisory
- Run 3 – FAA specified "required" route options identical to run 2 but also allowed customers to file CDRs and ad hoc routes
- Run 4 – FAA provided recommended route options in the CRI Planning Advisory but only flights going to satellite airports were included in the FEA definition

Each of the four runs used a hypothetical weather scenario with the FEA boundaries shown in Figure 3-3. The scenario consisted of an extended line of thunderstorms running from Cleveland Center (ZOB) down through Indianapolis Center (ZID) which had significant impact on traffic flows through the FEA. The original plan was to use the same FEA filters for each run, but collaboration on the definition of the filters proved to be a significant evaluation issue. Therefore, the filters were redefined for each run even though the weather scenario and FEA boundaries remained the same for all four runs.



A.1 Figure 3-3. March HITL FEA

Figures 3-4 and 3-5 show the CRI Planning Advisories that were developed and issued by the traffic managers for the first and second runs. Note that the Run 1 advisory *recommends* a number of Playbook routes while the Run 2 advisory *requires* those routes. The HITL participants were able to explore the effects of applying these differing levels of structure.

ATCSCC Advisory

ATCSCC ADVZY 022 05/05/2004 FEA001_PLN

MESSAGE:
NAME: PUBLIC FEA001
CONSTRAINED AREA: FEA THROUGH ZID AND ZOB
REASON: TSTMS
INCLUDE TRAFFIC: ARRIVING ZDC, ZNY, ZBW
FACILITIES INCLUDED: ALL
FLIGHT STATUS: ALL
VALID: FEA ENTRY TIME – FROM 1900 TO 2059

FLIGHTS IMPACTED: SEE ATTACHED FLIGHT LIST

REMARKS: CRI SUBMISSION WINDOW EXPIRES AT 1730Z.
CUSTOMERS SHOULD CONSIDER FILING ONE OF THE FOLLOWING PLAYBOOK ROUTES:

- CHOKEPOINTS EXCLUDING STL
- CAN1
- VUZ
- MGM
- CEW

Recommended Route Guidance

FLIGHTS ON THE FEA LIST THAT DO NOT HAVE A CRI SUBMITTED AND GRANTED WILL BE REROUTED BY THE FAA VIA THE TRADITIONAL REROUTE PROCESS TO AVOID THE FEA.

ASSOCIATED RESTRICTIONS:

MODIFICATIONS:

EFFECTIVE TIME: 051900 – 052059

SIGNATURE: 04/05/05 17:00

A.2 Figure 3-4. March HITL Run 1 CRI Planning Advisory

ATCSCC Advisory

ATCSCC ADVZY 033 05/05/2004 FEA002_PLN

MESSAGE:	NAME: PUBLIC FEA001 CONSTRAINED AREA: FEA THROUGH ZID AND ZOB REASON: TSTMS INCLUDE TRAFFIC: ARRIVING ZDC, ZNY, ZBW FACILITIES INCLUDED: ALL – ZID EXCLUDED FLIGHT STATUS: ALL VALID: FEA ENTRY TIME – FROM 1900 TO 2059 FLIGHTS IMPACTED: SEE ATTACHED FLIGHT LIST REMARKS: CRI SUBMISSION WINDOW EXPIRES AT 1730Z. CUSTOMERS ARE REQUIRED TO FILE ONE OF THE FOLLOWING PLAYBOOK ROUTES: CHOKEPOINTS EXCLUDING STL - CAN1 - VUZ - MGM - CEW FLIGHTS ON THE FEA LIST THAT DO NOT HAVE A CRI SUBMITTED AND GRANTED WILL BE REROUTED BY THE FAA VIA THE TRADITIONAL REROUTE PROCESS TO AVOID THE FEA. ASSOCIATED RESTRICTIONS: MODIFICATIONS:
EFFECTIVE TIME:	051900 – 052059
SIGNATURE:	04/05/05 17:00

Required Route Guidance

A.3 Figure 3-5. March HITL Run 2 CRI Planning Advisory

Table 3-1 lists the number of flights that were included in the CRI planning advisory for each run and the number of CRIs that were submitted. Since Run 4 was limited to flights arriving at satellite airports in ZDC, New York Center (ZNY), and ZBW, considerably fewer flights were included in the CRI Planning Advisory. The need for more CDRs and new Plays was also identified in the last run. CDRs and Play segments were not defined for many of the smaller airports included on the filtered FCA list. It was difficult for traffic managers to come up with reroutes quickly for some flights.

A.3.1 Table 3-1. March HITL Evaluation Statistics

Run	1	2	3	4
Number of Flights in CRI Planning Advisory	155	100	127	21
Number of CRIs Submitted	42	17	31	19

During the first HITL evaluation, customers identified the following potential benefits of the ICR concept and the associated new automation capabilities:

- Early notification of a pending constraint results in more effective constraint impact assessment and contingency planning.
- FAA recommended routes and the ROG capabilities provide a better understanding of FAA traffic management needs and limitations.
- Flight-specific ROG capabilities allowed customers to very quickly identify efficient route options that avoid the constraint and are likely to be operationally acceptable to the FAA.
- The customer ability to submit a preferred reroute that is likely to be accepted by the traffic managers should reduce the impact of reroutes, the need for tactical revisions, and schedule uncertainties.

Traffic managers identified the following potential benefits:

- Reroute modeling capabilities give traffic managers a valuable advance look at the impact of reroutes (including customer preferences) on sector counts.
- By providing a visual picture of the future traffic scenario, the Future Traffic Display provides a significantly enhanced understanding of the impact of reroutes on traffic, including the potential complexity and bunching of the traffic.
- The ICR concept and modeling capabilities enhance situational awareness and may reduce the need for phone communication.
- The increased certainty provided by modeling and the ICR concept may reduce the need for miles-in-trail (MIT) restrictions.

The following enhancements and refinements to the ICR concept and capabilities were identified:

- Local traffic managers should have a much greater role in the development of the CRI Planning Advisories.
- Local traffic managers should be able to use the modeling tools themselves and should be able to review and model CRIs as they are submitted.

- Local traffic managers should be able to sort or filter flights by the center traversed so that they can get a tailored view of the flights that impact their center.
- Flights for which CRIs were submitted should be readily identifiable in flight lists and the traffic situation display.
- Traffic managers could also use the ROG capabilities to aid them in identifying reroutes for flights for which CRIs are not submitted. The traffic management version should provide a view of options by city pair, instead of the flight-specific view more suited to customers' needs.
- Ground delay and altitude changes should also be options for inclusion in CRIs.
- Customers would like a graphical ("point and click") ad hoc route builder in ROG.
- The ROG capabilities would be improved with access to more and better route options.

The traffic management and customer participants in the first HITL felt that the ICR concept was promising and warranted further testing and validation in HITLs. The traffic managers felt much more comfortable with Run 2 in which customer options were restricted to 5 Playbook Plays. However, the other runs went well enough that the traffic managers felt that the less structured advisories might be viable, assuming the availability of tools, such as ROG and monitoring/ modeling capabilities, to increase the likelihood that customer-submitted routes are operationally acceptable and to enable the traffic managers to easily identify potential problem areas. In addition, the participants identified enhancements and refinements that would help address some of their concerns.

The participants recommended that the second HITL continue to focus on less structured CRI Planning Advisories since less structure would likely provide more benefit to customers. To support better understanding of the benefits of ICR to customers, it was also recommended that the prototypes be enhanced to collect more metrics.

15.4 3.4 Second Human-in-the-Loop Evaluation

The second HITL evaluation, held in May 2005, had the following general goals:

- Further refine and validate the ICR concept
- Increase the team's understanding of the capabilities necessary to support the ICR concept
- Better understand potential benefits of the ICR concept for both customers and traffic managers

In addition, based on the feedback at the March HITL evaluation, the May HITL evaluation had the following special objectives:

- Increase understanding of the local traffic managers' role in the ICR process
- Explore in greater depth the interactions between the national and local traffic managers
- Examine potential uses of ROG capabilities by traffic managers
- Analyze in greater detail the workload impact of the ICR process on the customers and traffic managers

For the May HITL evaluation, the prototypes were enhanced to include refinements recommended in March. The CRCT Reroute Modeling tools were provided to the local traffic managers. An additional flight list filter enabled local traffic managers to identify flights whose CRI routes traversed their facilities. CRI routes on both the list of flights and the traffic display were color-coded so traffic managers could more easily distinguish them from the original routes.

The ROG Play Summary capabilities were also introduced, providing decision support to traffic managers for developing route guidance and planning reroutes. The Play Summary was later renamed the Traffic Management Initiative (TMI) Builder. These new ROG capabilities helped to identify Playbook Plays that may be best suited to reroute a list of flights around a constraint by summarizing the flight list coverage by Playbook Play. It also listed city pairs that were not covered by Plays and city pairs that only have CDR matches.

The need for additional routes was identified in the March HITL evaluation. Historical ad hoc reroute databases were created for each of the customer participants using Post Operations Evaluation Tool (POET) queries. These ad hoc databases were available along with the pre-coordinated databases (CDRs, Plays and ATC Preferred Routes) and were used as a surrogate for customer flight planning systems. In addition, an Internet-based flight planning system from the Lockheed Martin Corporation was made available to customer participants for the May HITL.

15.4.1 3.4.1 Overview of Runs and Metrics

Four runs were conducted at the May evaluation. Three different weather scenarios were used (the same weather scenario was used in the second and third runs). A brief description of the weather scenario and the flights included in the CRI Planning Advisory for each of the four HITL runs follows:

- Run 1 – Weather spanning ZTL and ZDC with southbound traffic on J75 and J48
- Run 2 – Weather in ZID with southbound traffic on J6
- Run 3 – Weather in ZID with both southbound traffic on J6 and westbound traffic
- Run 4 – Weather in ZDC and ZTL with northbound traffic on Atlantic Route (AR) 1, AR3, AR7, and AR14

Unlike the March evaluation, the May evaluation addressed a variety of weather constraint scenarios which helped the participants to gain a better understanding of the potential for varied applicability of the ICR process. Table 3-2 provides some basic statistics on the scope of each HITL run and the number of CRIs submitted. In the first run, a small number of the CRIs that were submitted were not accepted by the traffic managers because the CRIs did not follow the Planning Advisory guidance and were considered “operationally unacceptable” even though the routes were obtained via ROG. This situation demonstrated both the need for enhancements to the ROG database and the recognition that some routes in the ROG database may not be acceptable in all operational scenarios. Interestingly, all of the CRIs submitted in the remaining May HITL runs were accepted. This could have been due to a number of reasons such as better initial route guidance or better adherence to the route guidance. Or it may have been because the traffic manager participants were only familiar with certain centers and may not have recognized all the CRIs that might be operationally unacceptable.

A.1.1 Table 3-2. May HITL Basic Statistics

Run	1	2	3	4
Number of Flights in CRI Planning Advisory	90	17	126	84
Number of CRIs Submitted	36	13	75	58
Number of Flights Rerouted by FAA	45	3	12	13

Table 3-2 also lists the number of flights that were rerouted by the FAA after the close of the CRI submission window. As in the previous HITL, some flights were not covered by CDRs or Playbook Plays. It was time-consuming in these cases to develop reroutes for those flights without CRIs. This problem identified the need for a capability, such as ROG, to aid the traffic managers in easily and efficiently identifying reroutes for flights without CRIs. It also served to highlight one of the benefits of ICR in that traffic managers have fewer individualized reroutes to generate when the customers submit (acceptable) CRIs.

For the May HITL, the prototypes were enhanced to collect and save additional data on delays and additional miles flown due to CRIs or FAA reroutes. Table 3-3 provides some of the key results from the May HITL, based on the change in time or distance from the route associated with a flight when the CRI Planning Advisory was issued. One finding is that the routes submitted by customers resulted in less delay than the reroutes implemented by the FAA. For example, consider Run 3. For customer-submitted CRIs, the average change in flight time was 5 minutes per flight; the average change in flight distance was 38 miles. For the FAA-assigned reroutes, the average change in flight time was 7 minutes per flight; the average change in flight distance was 48 miles. The maximum change per flight (both in terms of minutes and miles) was actually lower for the FAA-assigned routes. If CRIs prove to be operationally acceptable, as they were in most cases in these runs, then the ICR process could lead to significant cost savings for customers.

A.1.2 Table 3-3. May HITL Delay Statistics Comparing Customer-Submitted CRIs to FAA-Assigned Reroutes

Run		**1[3]**	**2**	**3**	**4**
Average Change in Flight Time (Minutes)	CRI	NA	8	5	8
	FAA	NA	10	7	16
Maximum Change in Flight Time (Minutes)	CRI	NA	15	20	93
	FAA	NA	13	17	41
Average Change in Flight Distance (Miles)	CRI	NA	65	38	64
	FAA	NA	72	48	136
Maximum Change in Flight Distance (Miles)	CRI	NA	100	140	688
	FAA	NA	100	106	259

Figures 3-6 and 3-7 contain an example of the CRI Planning Advisory and the final Route Advisory for Run 4. As can be seen from these figures, the route guidance listed in the CRI Planning Advisory became the required routes for flights without CRIs in the final Route Advisory. Therefore, customers submitting other preferences obtained, on average, more efficient reroutes than non-participants. It should also be noted that all flights would have likely received the routes in the final Route Advisory if the ICR process had not been used. Therefore, in this case, the customers who did not submit CRIs were not “penalized” for not participating in the ICR process.

[3] The data for HITL Run 1 is not available due to technical problems that occurred during that run.

ATCSCC Advisory

ATCSCC ADVZY 059 07/29/2004 FEA NO ARs PLN

CRI Planning Advisory

MESSAGE:	NAME: PUBLIC FEA NO ARs CONSTRAINED AREA: AR ROUTES REASON: WEATHER INCLUDE TRAFFIC: ALL TRAFFIC FACILITIES INCLUDED: ALL FLIGHT STATUS: ALL VALID: FEA ENTRY TIME – FROM 1900 TO 2200 FLIGHTS IMPACTED: ALL TRAFFIC VIA AR ROUTES 1, 3, 7 AND 14 REMARKS: CRI WINDOW OPEN UNTIL 1730Z. CUSTOMERS ARE ENCOURAGED TO CONSIDER SNOWBIRD 5 AND 7, NO_WHITE/NO_WAVEY OR FLORIDA NE 1 PLAYBOOK ROUTES OR A761 BI-DIRECTIONAL ASSOCIATED RESTRICTIONS: MODIFICATIONS:
EFFECTIVE TIME:	291900 – 292159
SIGNATURE:	04/07/29 17:00

A.2 Figure 3-6. May HITL – Run 4 CRI Planning Advisory

ATCSCC Advisory

ATCSCC ADVZY 059 06/02/2004 FCA001 RQD/FL

Required Route Advisory

MESSAGE: NAME: PUBLIC FCA NO ARs
CONSTRAINED AREA: AR ROUTES
REASON: WEATHER
INCLUDE TRAFFIC: ALL TRAFFIC
FACILITIES INCLUDED: ALL
FLIGHT STATUS: ALL
VALID: FEA ENTRY TIME – FROM 1900 TO 2200

FLIGHTS IMPACTED: ALL TRAFFIC VIA AR ROUTES 1, 3, 7 AND 14

REMARKS: SEE ATTACHED FLIGHT LIST FOR FLIGHT-SPECIFIC REROUTES.

MODELING SUMMARY: 58 CRI ROUTES SUBMITTED, 58 CRI ROUTES GRANTED.
AVERAGE DELAY: 8 MINUTES/ 64 NM

ASSOCIATED RESTRICTIONS: EXPECT J75 MIT AND POSSIBLE ADDITIONAL MIT OVHD GVE AND MOL

MODIFICATIONS: CUSTOMERS ARE ADVISED TO REFERENCE REROUTE MONITOR FOR POTENTIAL MODIFICATIONS OF SUBMITTED CRI ROUTES.

DEFAULT ROUTES:
A761
FLORIDA NE 1 PLAYBOOK
SNOWBIRD 5 AND 7 PLAYBOOK
NO WHITE/NO WAVEY PLAYBOOK

EFFECTIVE TIME: 022000 – 022259

SIGNATURE: 04/06/02 19:00

A.3 Figure 3-7. May HITL – Run 4 Required Route Advisory

15.4.2 3.4.2 Summary of Results

At the May HITL evaluation, the FCT continued to refine and gain a better understanding of the ICR concept and the capabilities needed to support the ICR process. The HITL runs were successful in addressing the special objectives of the evaluation, such as developing a better understanding of the roles of local traffic managers in the ICR process and their interactions with the national traffic managers. Early involvement of local traffic managers from the affected centers in the development of CRI Planning Advisories proved to be very beneficial to the ICR process, factoring in local constraints and route preferences. The availability of modeling capabilities and the Future Traffic Display to local traffic managers was also shown to be of value to the efficiency of the ICR process. The initial use of ROG capabilities by both local and national traffic managers also proved to be of value. Several enhancements were identified to make the tool more useful for traffic managers. As was noted in Section 3.4.1, the availability of additional metrics was also helpful in identifying the potential benefits of the ICR concept.

As a result of the May HITL, customers also made the following observations and recommendations:

- Including more definitive information from local traffic managers (including local limitations and route preferences) in the CRI Planning Advisory was beneficial to the customer planning and decision making process.
- The availability of a real time CRI impact assessment, based on modeling results, would be useful while customers are doing their planning.
- ROG enhancements were identified. In particular, routes available in ROG that are based on Playbook Plays go directly from the origin airport to the start of the Playbook Play and directly from the end of the Playbook Play to the destination airport. ROG needs an easier method for filling in the origin/destination segments and completing the routes based on Playbook Plays.
- Some customers would like to participate in the HITLs remotely from their operations centers.

Traffic managers made the following additional observations and recommendations:

- Local traffic managers would like automation support for sharing candidate reroutes with the national traffic manager.
- Easy graphical display of individual CRI routes would be useful.
- There was still concern about the workload required to review CRIs and coordinate with the national traffic manager.
- Better filtering of CRIs is needed so that local traffic managers can easily review only the flights that may impact their airspace.

In the group discussion at the completion of the May HITL evaluation, traffic managers expressed less concern about an ICR process with recommended route guidance, but they were still concerned about the workload involved in CRI review. Customers continued to express strong support for the ICR process even though there are workload issues for dispatchers. Customer participants continued to feel that the benefits would outweigh the upfront planning costs. The delay metrics collected during the HITL supported this viewpoint. A third HITL was planned to continue to address outstanding concerns and to get feedback from participants from additional FAA facilities and from additional customer representatives.

15.5 3.5 Third Human-in-the-Loop Evaluation

The third HITL evaluation, held in July 2005, had the same general goals and objectives as the May HITL. The focus on day one (July 20) was primarily on FAA issues, such as coordinating between local and national traffic managers to define constraints and approve CRIs. Customer participants joined on the second day (July 21) to interact and send in CRI messages for their flights. Metron Aviation facilitators traveled with the RMT-R/ROG prototype to two customer facilities allowing for remote participation. This allowed customers (American Airlines, ARINC[4]) to access their own flight planning systems as well as the ROG capabilities during the HITL evaluation.

The prototype tools were enhanced to include some refinements recommended in previous HITL evaluations. Some concerns about traffic manager workload were addressed by giving the local traffic managers the same CRCT modeling capabilities as the national traffic managers had. The capabilities allowed local traffic managers to more easily review CRIs for potential problems and communicate the results to the national traffic manager via the automation tools. A detailed ROG TMI Builder storyboard with potential future enhancements was also presented to the traffic managers.

15.5.1 3.5.1 Overview of Runs and Metrics

Four runs were conducted at the July evaluation, each with its own weather scenario:

- Run 1 – Weather in Fort Worth Center (ZFW) with arrivals into Dallas-Fort Worth International Airport (DFW) and DAL over Bonham (BYP) included in CRI Planning Advisory
- Run 2 – Weather in Kansas City Center (ZKC) with eastbound traffic into ORD, IAD, BWI, PHL, and TEB included in CRI Planning Advisory
- Run 3 – Weather in Atlanta Center (ZTL) with flights at or above FL240 included in CRI Planning Advisory, but exempting arrivals into ATL and Jacksonville Center
- Run 4 – Weather in Chicago Center (ZAU) with flights arriving at ORD, Chicago Midway Airport (MDW), MSP, and DTW included in CRI Planning Advisory

In addition, a baseline for Run 2 was done as a basis for comparison, with traffic managers assigning all routes instead of using the ICR process.

The July HITL evaluation continued to explore additional weather scenarios, examining which types of scenarios were best suited to the ICR process. Table 3-4 provides some basic statistics on the each run. Compared to previous evaluations, in the July HITL the local traffic managers were more actively involved in planning the constraint, offering route

[4] ARINC is located in Annapolis, Maryland, and provides operations center services to business aviation customers.

guidance, and determining whether CRI routes were acceptable. So when local traffic managers identified CRIs in Run 1 that were not acceptable, they used ROG capabilities to find alternative routes for each of those flights and coordinated with the national traffic manager to assign those recommended routes.

A.1.1 Table 3-4. July HITL Basic Statistics

Run	1	2	3	4
Number of Flights in CRI Planning Advisory	44	54	84	164
Number of CRIs Submitted	25	49	38	31
Number of CRIs Accepted	21	49	38	31

The remote customer participants were able to successfully submit their preferences and provided feedback via teleconference during discussions. They found the advisory information and CRI response time sufficient for their planning purposes.

The July HITL delay statistics (Table 3-5) confirm the findings from May that in many situations, customers benefit from providing CRIs for their flights. The average delay, both time and delta distance, for routes assigned by traffic managers exceeded that of the CRIs on each run.

A.1.2 Table 3-5. July HITL Delay Statistics Comparing Customer-Submitted CRIs to FAA-Assigned Reroutes

Run		1	2	3	4
Average Change in Flight Time (Minutes)	CRI	15	3	6	5
	FAA	17	16	18	16
Maximum Change in Flight Time (Minutes)	CRI	36	18	60	17
	FAA	46	39	37	54
Average Change in Flight Distance (Miles)	CRI	109	33	36	42
	FAA	123	97	129	112
Maximum Change in Flight Distance (Miles)	CRI	270	196	392	125
	FAA	384	185	242	344

In addition, Run 2 was compared to a baseline run (Table 3-6), in which traffic managers rerouted the flights by applying Playbook Plays as they do today (customers did not participate in this run). In the baseline run, of the 49 flights that went through the FEA, 46 were captured by the Playbook routes selected by the traffic managers. The other 3 flights did not meet criteria for any of the selected Playbook routes and were left to be rerouted tactically by local traffic managers. In Run 2, those same 3 flights had CRIs and so did not need tactical rerouting.

Run 2, using the ICR process, reduced the total number of flights the FAA needed to reroute, from 46 to 9. Additionally, customer CRIs reduced the average delay minutes and reroute distances required overall. The baseline run with 46 flights on 3 Playbook routes also caused sector alerts in ZDC airspace (in sectors ZDC36 and ZDC39), unlike Run 2.

A.1.3 Table 3-6. Comparing ICR Process (Run 2) to Current Process (Baseline)

		Baseline	**Run 2**
Number of Flights in FEA		49	54[5]
Number of Flights Rerouted by FAA		46	9
Number of Flights Not Rerouted		3	0
Average Change in Flight Time (Minutes)	CRI		3
	FAA	11	16
Maximum Change in Flight Time (Minutes)	CRI		18
	FAA	27	39
Average Change in Flight Distance (Miles)	CRI		33
	FAA	89	97
Maximum Change in Flight Distance (Miles)	CRI		196
	FAA	218	185

5 During the 30 minute window when the customers were submitting their preferences, additional flights (pop-ups) were captured by the FEA list.

15.5.2 3.5.2 Summary of Results

At the July HITL evaluation, the FCT gained a clearer picture of the benefits of the ICR process. Both customers and traffic managers found benefit in the early coordination between local and national traffic managers. For customers, the early coordination resulted in higher quality route guidance in the CRI Planning Advisory. For traffic managers, it addressed local concerns earlier, freeing up time to deal with more tactical events, such as pop-up flights and exceptions.

Customers also made the following additional observations:

- Flights for which the customers submitted CRIs typically took shorter, quicker reroutes than when the traffic managers assigned routes.
- Submitting their own CRIs early gave customers better predictability than waiting for traffic managers to assign routes.
- While submitting CRIs meant doing more work early in the process, customers preferred that over responding tactically to unexpected FAA-imposed reroutes.

Traffic managers made the following additional observations:

- The reduced number of flights the traffic managers needed to reroute was a definite advantage.
- CRIs tended to disperse the flights, causing fewer congestion problems than when traffic managers assigned all the flights to Playbook Plays.
- Having modeling capabilities to assess the impacts of CRIs and planned required reroutes on local traffic flows, local traffic managers were in a better position to make early decisions to reduce local impact rather than waiting to handle the traffic tactically.
- Additional coordination between local traffic managers and the national traffic manager prior to issuing the final Route Advisory benefited both local and national traffic managers. The resulting Route Advisories included specific input from those local facilities needing additional actions (such as MIT restrictions) to support the national reroute initiative.

As a result of the July HITL evaluation, the FCT moved ahead with the next steps toward implementing the ICR concept.

16 Section 4

17 Summary and Next Steps

Six evaluations were conducted in FY05 to develop, refine, and validate Full ICR., which provides an enhanced, more collaborative approach to rerouting. As a result of the FY05 evaluations, the FCT decided to recommend the ICR concept and associated capabilities for implementation.

The evaluations showed that the concept will result in a more collaborative and efficient process for resolving en route congestion. The evaluation participants also felt that the effective use of the ICR process would likely improve the predictability of en route demand, which is a benefit for customers and traffic managers. On the customer side, predictability is improved by getting better information on the constraints, alternative routings that will be acceptable to the traffic managers, and the potential delays (from reroute modeling). By submitting reroute preferences, flights will more likely be rerouted on flyable routes requiring fewer requests for exceptions and less iteration of flight plans. On the traffic manager side, predictability is improved by getting earlier information on the impact of various rerouting strategies (from reroute modeling), and by earlier compliance with reroutes, which improves the ability of ETMS to accurately predict a flight through the system.

The evaluations also demonstrated several other important benefits of the ICR process. The customers have an incentive to be proactive, because the planning advisory gives them a better understanding of alternatives acceptable to traffic management and they have more input into how their flights are routed. Traffic managers have fewer flights to reroute prior to departure and need to do fewer tactical reroutes, so they have more time to make internal adjustments to flows (if necessary) that support the reroute initiative.

Finally, using a wide variety of operational scenarios during the evaluations helped identify the types of traffic management problems for which the ICR Concept was well suited. In the evaluations, situations with long lead times that were not too close to major airports appeared to work best. These situations allow adequate time for planning and coordination, while still providing significant improvements in predictability for both traffic managers and customers.

17.1 4.1 Concept Benefits and Findings

This section provides a summary of the potential benefits and other findings identified for each key ICR concept element.

17.1.1 4.1.1 Preplanning Coordination between Local and National Traffic Managers

As the ICR Concept evolved, the local traffic managers got involved earlier and in more significant ways than originally envisioned. They expect to have a major role in identifying problems for which the ICR process is appropriate, defining the FEA and reroute options for the CRI Planning Advisory, monitoring CRI submissions to spot local problems, and proposing routes to be assigned in the Route Advisory.

Early input of local facility limitations, constraints, and special needs when defining constraints benefited both traffic managers and customers. Traffic managers found that it led to more effective FEA/FCAs and more realistic filters to define the constraint. Customers found that it led to more informative and practical guidance in the CRI Planning Advisory.

17.1.2 4.1.2 CRI Planning Advisory

Because the CRI Planning Advisory came out early in the process, customers found they had the necessary time to thoroughly evaluate multiple route options for each flight, resulting in more informed decision making. They also found advantages to receiving guidance on which routes were recommended and gained understanding of traffic managers' concerns.

For traffic managers, the CRI Planning Advisory let them balance structuring the traffic flows and accommodating customer preferences. Over the course of the evaluations, the traffic managers became more confident that they could identify unacceptable routes before they caused problems. As a result, traffic managers issued less restrictive CRI Planning Advisories and found that customers were more likely to submit acceptable routes.

17.1.3 4.1.3 Reroute Monitor

Customers found that using Reroute Monitor to see reroute options for each of their flights supported their early involvement and informed decision making. After the Route Advisory is issued, customers found that Reroute Monitor makes it much easier to determine whether the preference they had submitted was now assigned.

Traffic managers found Reroute Monitor helpful in viewing reroute options before they were issued in the CRI Planning Advisory. Once the CRI Planning Advisory went out, local traffic managers had a bigger role than first expected in monitoring CRI submissions to spot local problems. Using Reroute Monitor, they were more easily able to identify which CRIs followed the route guidance, so they could assess how those flights might impact their area of responsibility. As a result, they were more likely to take corrective action based on the needs of their airspace or the system as a whole.

17.1.4 4.1.4 Route Options Generation (ROG)

Both traffic managers and customers valued ROG capabilities as an important component of ICR as well as a stand-alone capability. The ROG automation reduced traffic manager workload by helping distinguish those routes that avoid the constraint from those that traverse the constraint. It also provided a quick view analysis detailing how many flights would be impacted by each reroute option for better decision making. With its filtering and mapping capabilities, ROG provided a flexible means for traffic managers to analyze multiple route options and select the best guidance for the customers.

Initially, customers were concerned that submitted routes would be rejected repeatedly for violating rules they could not check themselves. Having the pre-coordinated routes in ROG meant that the routes would have a higher likelihood of FAA acceptance, reducing the number of flight plan iterations for the customer. In addition, the ROG automation reduced customer workload by distinguishing those routes that avoid the constraint from those that do not. With its filtering and mapping capabilities, ROG provided a flexible means for customers to analyze multiple route options and select a preferred route.

17.1.5 4.1.5 Constraint Resolution Intent (CRI) Message

Customers perceived the ability to submit their reroute preferences via an acceptable CRI for each flight as a way to save money, because they felt they would be able to fly a route that better met their needs, with less time spent on iterating through route planning. As customers took a more pro-active approach to providing their route preferences earlier in the process, they identified significant cost savings by both flying better routes and by spending less time planning routes multiple times at short notice.

Traffic managers found that knowing where customers wanted to reroute their flights to avoid a known constraint was an extremely important piece of their decision making process. For example, when they were concerned about congestion forming in sectors through which flights with CRIs were flying, they assigned flights without CRIs to routes that avoided those sectors.

17.1.6 4.1.6 Reroute Modeling

With the use of Reroute Modeling, the traffic managers were able to view customer preferred reroutes, model their impact, identify problematic routes, and accept customer preferences that did not negatively impact the system. By understanding potential impacts of the reroutes and taking corrective action in the planning stage, traffic managers saw an increased predictability within the system. By allowing customers more opportunity to fly routes they prefer, traffic managers had higher confidence that flights would fly their filed routes and tactical reroutes would be reduced. Reroute Modeling also identified areas of underutilized airspace once customer preferences had been modeled and traffic managers were able to balance demand by rerouting remaining flights into that airspace.

Also of note, these evaluations showed that when customers were provided with FAA guidance and allowed to submit reroute preferences, those routes varied enough so as not to cause bunching or sector alerts. Traffic managers easily monitored this graphically when modeling CRIs using the Future Traffic Display prior to the Route Advisory.

17.1.7 4.1.7 Route Advisory

Customers perceived a benefit from seeing the impact of the reroutes on a flight-specific basis, as listed in this advisory. For flights for which a submitted CRI was accepted, this provided added predictability. Additionally, modeling information included in the advisory gave customers insight into the overall impact of the reroutes, which improved subsequent planning.

With the customers doing the work to generate reroutes (their preferences) and submitting them to the FAA, there were fewer flights left that traffic managers had to develop reroutes for. This is potentially a big time savings, especially for local traffic managers who currently enter route amendments manually into the flight data system and for controllers who then clear those amendments to the flight crews.

17.2 4.2 Next Steps

As the next step toward implementing the ICR Concept, the FCT has developed a phased implementation plan. The initial phase of ICR focuses mainly on procedural changes, with minor enhancements to existing ETMS tools, such as Reroute Monitor. A new automation capability recommended for Initial ICR is the ROG capabilities within RMT. The operational concept and functional requirements for Initial ICR have been documented [3, 4].

Additional evaluations exploring the feasibility of Initial ICR were conducted in FY06 and will be documented in a separate report. Further evaluations are needed to refine the concept and requirements for Initial ICR, as well as to develop the procedures and training for its use. A joint CDM FCT/Flow Evaluation Team (FET) Sub-group has been formed to oversee Initial ICR implementation. Research also continues on potential integration opportunities with Airspace Flow Programs (AFPs).

A subsequent phase in implementing the ICR Concept would add the Future Traffic Display to ETMS. As the first step, Future Traffic Display would show only the future positions of the route currently known to ETMS for each flight. Future phases would add Reroute Modeling capabilities to ETMS, expand Future Traffic Display to show future positions along proposed reroutes, and integrate ROG functionality more fully. The timetable for these enhancements is to be decided by the FAA.

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19 Glossary

AFP	Airspace Flow Program
AR	Atlantic Route
ATA	Air Transport Association
ATC	Air Traffic Control
ATCSCC	Air Traffic Control System Command Center
BYP	Bonham (Texas) fix
CAASD	Center for Advanced Aviation System Development
CCSD	Common Constraint Situation Display
CDM	Collaborative Decision Making
CDR	Coded Departure Route
CRCT	Collaborative Routing Coordination Tools
CRI	Constraint Resolution Intent
CSM	Computer Simulation Manager
DFW	Dallas-Fort Worth International Airport
ETMS	Enhanced Traffic Management System
FAA	Federal Aviation Administration
FCA	Flow Constrained Area
FCT	designator for the Future Concepts of Flow Management Sub-Team (formerly the ICE-FM)
FEA	Flow Evaluation Area
FET	Flow Evaluation Team
FY05	Fiscal Year 2005
FY06	Fiscal Year 2006
HCI	human-computer interface
HITL	human-in-the-loop
ICE-FM	Integrated Concepts for the Evolution of Flow Management (now the FCT)
ICR	Integrated Collaborative Rerouting
MDW	Chicago Midway Airport
MIT	miles-in-trail
NAS	National Airspace System
NBAA	National Business Aviation Association

NOM	National Operational Manager
NTMO	National Traffic Management Officer
POET	Post Operations Evaluation Tool
RMT	Route Management Tool
RMT-R	Route Management Tool (research version)
ROG	Route Options Generation
STMC	Supervisory Traffic Management Coordinator
TFM	Traffic Flow Management
TMC	Traffic Management Coordinator
TMI	traffic management initiative
TMU	Traffic Management Unit
TSD	Traffic Situation Display
ZBW	Boston Center
ZDC	Washington Center
ZDV	Denver Center
ZFW	Fort Worth Center
ZID	Indianapolis Center
ZKC	Kansas City Center
ZMP	Minneapolis Center
ZNY	New York Center
ZOB	Cleveland Center